

# 54AC11112, 74AC11112 DUAL J-K NEGATIVE-EDGE-TRIGGERED FLIP-FLOPS WITH CLEAR AND PRESET

SCAS073A – JUNE 1989 – REVISED APRIL 1993

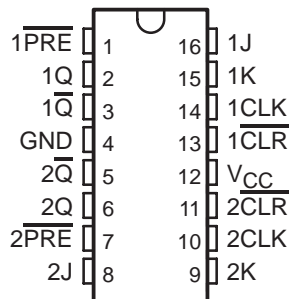
- Flow-Through Architecture Optimizes PCB Layout
- Center-Pin  $V_{CC}$  and GND Configuration Minimizes High-Speed Switching Noise
- EPIC™ (Enhanced-Performance Implanted CMOS) 1- $\mu$ m Process
- 500-mA Typical Latch-Up Immunity at 125°C
- ESD Protection Exceeds 2000 V, MIL STD-883C Method 3015
- Package Options Include Plastic Small-Outline Packages, Ceramic Chip Carriers, and Standard Plastic and Ceramic 300-mil DIPs

## description

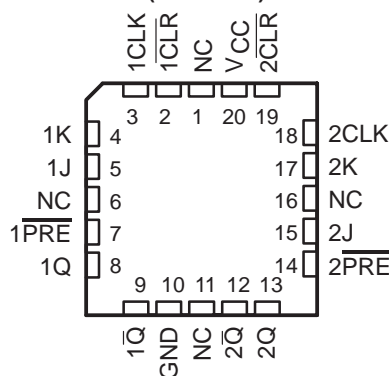
These devices contain two independent J-K negative-edge-triggered flip-flops. A low level at the preset ( $\overline{PRE}$ ) or clear ( $\overline{CLR}$ ) inputs sets or resets the outputs regardless of the levels of the other inputs. When preset and clear are inactive (high), data at the J and K inputs meeting the setup time requirements are transferred to the outputs on the negative-going edge of the clock pulse. Clock triggering occurs at a voltage level and is not directly related to the fall time of the clock pulse. Following the hold time interval, data at the J and K inputs may be changed without affecting the levels at the outputs. These versatile flip-flops can perform as toggle flip-flops by tying J and K high.

The 54AC11112 is characterized for operation over the full military temperature range of  $-55^{\circ}\text{C}$  to  $125^{\circ}\text{C}$ . The 74AC11112 is characterized for operation from  $-40^{\circ}\text{C}$  to  $85^{\circ}\text{C}$ .

54AC11112 . . . J PACKAGE  
74AC11112 . . . D OR N PACKAGE  
(TOP VIEW)



54AC11112 . . . FK PACKAGE  
(TOP VIEW)



NC – No internal connection

FUNCTION TABLE  
(each gate)

| INPUTS           |                  |     |   |   | OUTPUTS        |                  |
|------------------|------------------|-----|---|---|----------------|------------------|
| $\overline{PRE}$ | $\overline{CLR}$ | CLK | J | K | Q              | $\overline{Q}$   |
| L                | H                | X   | X | X | H              | L                |
| H                | L                | X   | X | X | L              | H                |
| L                | L                | X   | X | X | H <sup>†</sup> | H <sup>†</sup>   |
| H                | H                | ↓   | L | L | $Q_0$          | $\overline{Q}_0$ |
| H                | H                | ↓   | H | L | H              | L                |
| H                | H                | ↓   | L | H | L              | H                |
| H                | H                | ↓   | H | H | Toggle         |                  |
| H                | H                | H   | X | X | $Q_0$          | $\overline{Q}_0$ |

<sup>†</sup> This configuration is nonstable; that is, it will not persist when either  $\overline{PRE}$  or  $\overline{CLR}$  returns to its inactive (high) level.

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PRODUCTION DATA information is current as of publication date. Products conform to specifications per the terms of Texas Instruments standard warranty. Production processing does not necessarily include testing of all parameters.



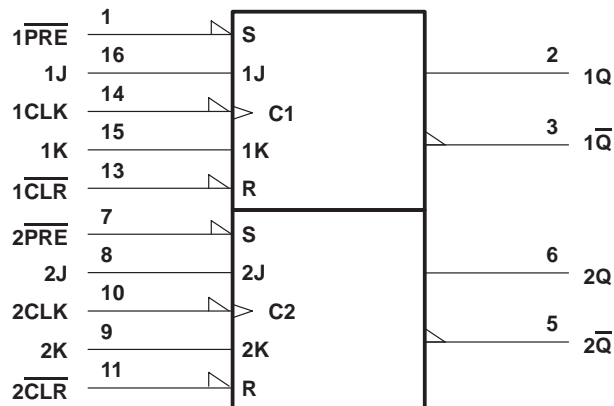
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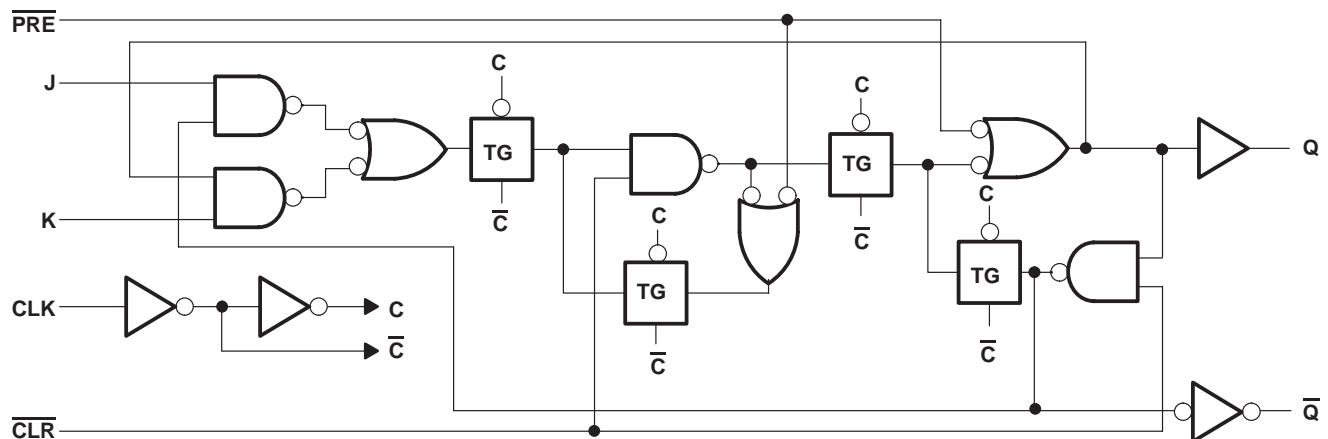
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## logic symbol†



† This symbol is in accordance with ANSI/IEEE Std 91-1984 and IEC Publication 617-12.  
Pin numbers shown are for the D, J, and N packages.

## logic diagram, each flip-flop (positive logic)



## absolute maximum ratings over operating free-air temperature range (unless otherwise noted)‡

|  |                            |
|--|----------------------------|
| Supply voltage range, $V_{CC}$ .....                                 | -0.5 V to 7 V              |
| Input voltage range, $V_I$ (see Note 1) .....                        | -0.5 V to $V_{CC} + 0.5$ V |
| Output voltage range, $V_O$ (see Note 1) .....                       | -0.5 V to $V_{CC} + 0.5$ V |
| Input clamp current, $I_{IK}$ ( $V_I < 0$ or $V_I > V_{CC}$ ) .....  | $\pm 20$ mA                |
| Output clamp current, $I_{OK}$ ( $V_O < 0$ or $V_O > V_{CC}$ ) ..... | $\pm 50$ mA                |
| Continuous output current, $I_O$ ( $V_O = 0$ to $V_{CC}$ ) .....     | $\pm 50$ mA                |
| Continuous current through $V_{CC}$ or GND .....                     | $\pm 100$ mA               |
| Storage temperature range .....                                      | -65°C to 150°C             |

‡ Stresses beyond those listed under "absolute maximum ratings" may cause permanent damage to the device. These are stress ratings only and functional operation of the device at these or any other conditions beyond those indicated under "recommended operating conditions" is not implied. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.

NOTE 1: The input and output voltage ratings may be exceeded if the input and output current ratings are observed.

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## recommended operating conditions

|                     |                                    | 54AC1112                |          |     | 74AC1112 |          |     | UNIT |
|---------------------|------------------------------------|-------------------------|----------|-----|----------|----------|-----|------|
|                     |                                    | MIN                     | NOM      | MAX | MIN      | NOM      | MAX |      |
| $V_{CC}$            | Supply voltage                     | 3                       | 5        | 5.5 | 3        | 5        | 5.5 | V    |
| $V_{IH}$            | High-level input voltage           | $V_{CC} = 3\text{ V}$   | 2.1      |     | 2.1      |          |     | V    |
|                     |                                    | $V_{CC} = 4.5\text{ V}$ | 3.15     |     | 3.15     |          |     |      |
|                     |                                    | $V_{CC} = 5.5\text{ V}$ | 3.85     |     | 3.85     |          |     |      |
| $V_{IL}$            | Low-level input voltage            | $V_{CC} = 3\text{ V}$   |          |     | 0.9      |          |     | V    |
|                     |                                    | $V_{CC} = 4.5\text{ V}$ |          |     | 1.35     |          |     |      |
|                     |                                    | $V_{CC} = 5.5\text{ V}$ |          |     | 1.65     |          |     |      |
| $V_I$               | Input voltage                      | 0                       | $V_{CC}$ |     | 0        | $V_{CC}$ |     | V    |
| $V_O$               | Output voltage                     | 0                       | $V_{CC}$ |     | 0        | $V_{CC}$ |     | V    |
| $I_{OH}$            | High-level output current          | $V_{CC} = 3\text{ V}$   |          |     | -4       |          |     | mA   |
|                     |                                    | $V_{CC} = 4.5\text{ V}$ |          |     | -24      |          |     |      |
|                     |                                    | $V_{CC} = 5.5\text{ V}$ |          |     | -24      |          |     |      |
| $I_{OL}$            | Low-level output current           | $V_{CC} = 3\text{ V}$   |          |     | 12       |          |     | mA   |
|                     |                                    | $V_{CC} = 4.5\text{ V}$ |          |     | 24       |          |     |      |
|                     |                                    | $V_{CC} = 5.5\text{ V}$ |          |     | 24       |          |     |      |
| $\Delta t/\Delta v$ | Input transition rise or fall rate | 0                       | 10       |     | 0        | 10       |     | ns/V |
| $T_A$               | Operating free-air temperature     | -55                     | 125      |     | -40      | 85       |     | °C   |

## electrical characteristics over recommended operating free-air temperature range (unless otherwise noted)

| PARAMETER                         | TEST CONDITIONS                  | $V_{CC}$ | $T_A = 25^\circ\text{C}$ |     |      | 54AC1112  |      | 74AC1112 |     | UNIT          |
|-----------------------------------|----------------------------------|----------|--------------------------|-----|------|-----------|------|----------|-----|---------------|
|                                   |                                  |          | MIN                      | TYP | MAX  | MIN       | MAX  | MIN      | MAX |               |
| $V_{OH}$                          | $I_{OH} = -50\ \mu\text{A}$      | 3 V      | 2.9                      |     |      | 2.9       |      | 2.9      |     | V             |
|                                   |                                  | 4.5 V    | 4.4                      |     |      | 4.4       |      | 4.4      |     |               |
|                                   |                                  | 5.5 V    | 5.4                      |     |      | 5.4       |      | 5.4      |     |               |
|                                   | $I_{OH} = -4\ \text{mA}$         | 3 V      | 2.58                     |     |      | 2.4       |      | 2.48     |     |               |
|                                   |                                  | 4.5 V    | 3.94                     |     |      | 3.7       |      | 3.8      |     |               |
|                                   |                                  | 5.5 V    | 4.94                     |     |      | 4.7       |      | 4.8      |     |               |
|                                   |                                  | 5.5 V    |                          |     |      | 3.85      |      |          |     |               |
| $I_{OH} = -50\ \text{mA}^\dagger$ | 5.5 V                            |          |                          |     | 3.85 |           |      |          |     |               |
| $I_{OH} = -75\ \text{mA}^\dagger$ | 5.5 V                            |          |                          |     |      |           | 3.85 |          |     |               |
| $V_{OL}$                          | $I_{OL} = 50\ \mu\text{A}$       | 3 V      |                          |     |      | 0.1       |      | 0.1      |     | V             |
|                                   |                                  | 4.5 V    |                          |     |      | 0.1       |      | 0.1      |     |               |
|                                   |                                  | 5.5 V    |                          |     |      | 0.1       |      | 0.1      |     |               |
|                                   | $I_{OL} = 12\ \text{mA}$         | 3 V      |                          |     |      | 0.36      |      | 0.5      |     |               |
|                                   |                                  | 4.5 V    |                          |     |      | 0.36      |      | 0.5      |     |               |
|                                   | $I_{OL} = 24\ \text{mA}$         | 4.5 V    |                          |     |      | 0.36      |      | 0.5      |     |               |
|                                   |                                  | 5.5 V    |                          |     |      | 0.36      |      | 0.5      |     |               |
| $I_{OL} = 50\ \text{mA}^\dagger$  | 5.5 V                            |          |                          |     |      |           | 1.65 |          |     |               |
| $I_{OL} = 75\ \text{mA}^\dagger$  | 5.5 V                            |          |                          |     |      |           | 1.65 |          |     |               |
| $I_I$                             | $V_I = V_{CC}$ or GND            | 5.5 V    |                          |     |      | $\pm 0.1$ |      | $\pm 1$  |     | $\mu\text{A}$ |
| $I_{CC}$                          | $V_I = V_{CC}$ or GND, $I_O = 0$ | 5.5 V    |                          |     |      | 4         |      | 80       |     | $\mu\text{A}$ |
| $C_i$                             | $V_I = V_{CC}$ or GND            | 5 V      |                          |     |      | 3.5       |      |          | pF  |               |

<sup>†</sup> Not more than one output should be tested at a time, and the duration of the test should not exceed 10 ms.



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## timing requirements, $V_{CC} = 3.3\text{ V} \pm 0.3\text{ V}$ (see Figure 1)

|                    |                                    |   | $T_A = 25^\circ\text{C}$ |     | 54AC11112 |     | 74AC11112 |     | UNIT |
|--------------------|------------------------------------|---|--------------------------|-----|-----------|-----|-----------|-----|------|
|                    |                                    |   | MIN                      | MAX | MIN       | MAX | MIN       | MAX |      |
| $f_{\text{clock}}$ | Clock frequency                    |   | 0                        | 100 | 0         | 70  | 0         | 70  | MHz  |
| $t_w$              | Pulse duration                     | $\overline{\text{PRE}}$ or $\overline{\text{CLR}}$ low      | 5                        |     | 5         |     | 5         |     | ns   |
|                    |                                    | CLK low or CLK high   | 5                        |     | 5         |     | 5         |     |      |
| $t_{\text{su}}$    | Setup time before CLK $\downarrow$ | Data high or low  | 5                        |     | 5         |     | 5         |     | ns   |
|                    |                                    | $\overline{\text{PRE}}$ or $\overline{\text{CLR}}$ inactive | 2.5                      |     | 2.5       |     | 2.5       |     |      |
| $t_h$              | Hold time after CLK $\downarrow$   |   | 0.5                      |     | 0.5       |     | 0.5       |     | ns   |

## timing requirements, $V_{CC} = 5\text{ V} \pm 0.5\text{ V}$ (see Figure 1)

|                    |                                    |   | $T_A = 25^\circ\text{C}$ |     | 54AC11112 |     | 74AC11112 |     | UNIT |
|--------------------|------------------------------------|---|--------------------------|-----|-----------|-----|-----------|-----|------|
|                    |                                    |   | MIN                      | MAX | MIN       | MAX | MIN       | MAX |      |
| $f_{\text{clock}}$ | Clock frequency                    |   | 0                        | 125 | 0         | 125 | 0         | 125 | MHz  |
| $t_w$              | Pulse duration                     | $\overline{\text{PRE}}$ or $\overline{\text{CLR}}$ low      | 4                        |     | 4         |     | 4         |     | ns   |
|                    |                                    | CLK low or CLK high   | 4                        |     | 4         |     | 4         |     |      |
| $t_{\text{su}}$    | Setup time before CLK $\downarrow$ | Data high or low  | 3.5                      |     | 3.5       |     | 3.5       |     | ns   |
|                    |                                    | $\overline{\text{PRE}}$ or $\overline{\text{CLR}}$ inactive | 2                        |     | 2         |     | 2         |     |      |
| $t_h$              | Hold time after CLK $\downarrow$   |   | 1                        |     | 1         |     | 1         |     | ns   |

## switching characteristics over recommended operating free-air temperature range, $V_{CC} = 3.3\text{ V} \pm 0.3\text{ V}$ (unless otherwise noted) (see Figure 1)

| PARAMETER        | FROM (INPUT)                                       | TO (OUTPUT)                | $T_A = 25^\circ\text{C}$ |     |     | 54AC11112 |      | 74AC11112 |     | UNIT |
|------------------|--|----------------------------|--------------------------|-----|-----|-----------|------|-----------|-----|------|
|                  |  |                            | MIN                      | TYP | MAX | MIN       | MAX  | MIN       | MAX |      |
| $f_{\text{max}}$ |  |                            | 100                      | 150 |     | 100       |      | 100       |     | MHz  |
| $t_{\text{PLH}}$ | $\overline{\text{PRE}}$ or $\overline{\text{CLR}}$ | Q or $\overline{\text{Q}}$ | 1.5                      | 4.9 | 6.7 | 1.5       | 7.6  | 1.5       | 7.3 | ns   |
| $t_{\text{PHL}}$ |  |                            | 1.5                      | 7   | 9.2 | 1.5       | 10.3 | 1.5       | 9.9 |      |
| $t_{\text{PLH}}$ | CLK  | Q or $\overline{\text{Q}}$ | 1.5                      | 5.4 | 7.1 | 1.5       | 7.9  | 1.5       | 7.6 | ns   |
| $t_{\text{PHL}}$ |  |                            | 1.5                      | 6   | 7.9 | 1.5       | 9    | 1.5       | 8.5 |      |

## switching characteristics over recommended operating free-air temperature range, $V_{CC} = 5\text{ V} \pm 0.5\text{ V}$ (unless otherwise noted) (see Figure 1)

| PARAMETER        | FROM (INPUT)                                       | TO (OUTPUT)                | $T_A = 25^\circ\text{C}$ |     |     | 54AC11112 |     | 74AC11112 |     | UNIT |
|------------------|--|----------------------------|--------------------------|-----|-----|-----------|-----|-----------|-----|------|
|                  |  |                            | MIN                      | TYP | MAX | MIN       | MAX | MIN       | MAX |      |
| $f_{\text{max}}$ |  |                            | 125                      | 175 |     | 125       |     | 125       |     | MHz  |
| $t_{\text{PLH}}$ | $\overline{\text{PRE}}$ or $\overline{\text{CLR}}$ | Q or $\overline{\text{Q}}$ | 1.5                      | 3.3 | 5.1 | 1.5       | 5.6 | 1.5       | 5.4 | ns   |
| $t_{\text{PHL}}$ |  |                            | 1.5                      | 4.6 | 6.7 | 1.5       | 7.7 | 1.5       | 7.3 |      |
| $t_{\text{PLH}}$ | CLK  | Q or $\overline{\text{Q}}$ | 1.5                      | 3.4 | 5.1 | 1.5       | 5.8 | 1.5       | 5.6 | ns   |
| $t_{\text{PHL}}$ |  |                            | 1.5                      | 4.2 | 6.3 | 1.5       | 7.4 | 1.5       | 7   |      |

## operating characteristics, $V_{CC} = 5\text{ V}$ , $T_A = 25^\circ\text{C}$

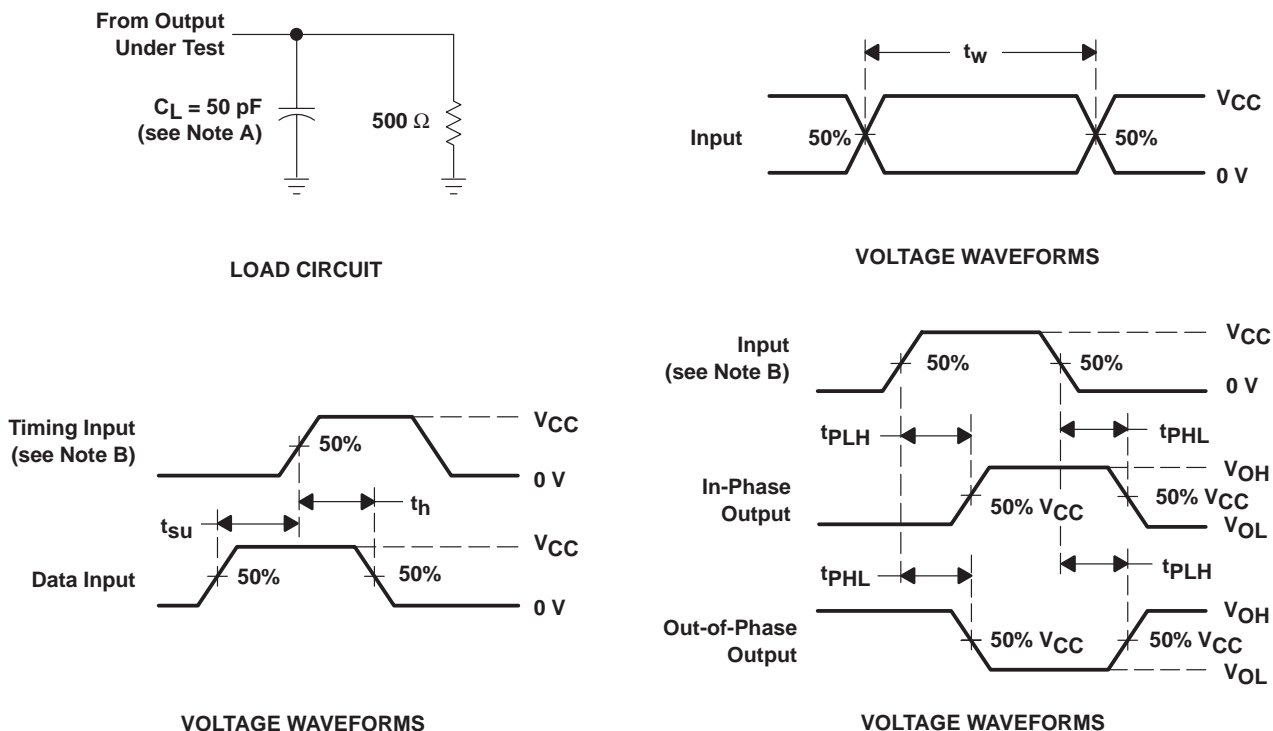
| PARAMETER       | TEST CONDITIONS   | TYP | UNIT |
|-----------------|---|-----|------|
| $C_{\text{pd}}$ | Power dissipation capacitance per gate<br>$C_L = 50\text{ pF}$ , $f = 1\text{ MHz}$ | 37  | pF   |



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**WITH CLEAR AND PRESET**

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**PARAMETER MEASUREMENT INFORMATION**



- NOTES: A.  $C_L$  includes probe and jig capacitance.  
 B. All input pulses are supplied by generators having the following characteristics:  $PRR \leq 10 \text{ MHz}$ ,  $Z_O = 50 \Omega$ ,  $t_r = 3 \text{ ns}$ ,  $t_f = 3 \text{ ns}$ .  
 C. The outputs are measured one at a time with one input transition per measurement.

**Figure 1. Load Circuit and Voltage Waveforms**



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|                    |  |
|--------------------|--|
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| Automotive         | <a href="http://www.ti.com/automotive">www.ti.com/automotive</a>         |
| Broadband          | <a href="http://www.ti.com/broadband">www.ti.com/broadband</a>           |
| Digital Control    | <a href="http://www.ti.com/digitalcontrol">www.ti.com/digitalcontrol</a> |
| Medical            | <a href="http://www.ti.com/medical">www.ti.com/medical</a>               |
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